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FARMERS' BULLETIN 292.

COST OF FILLING SILOS.

BY

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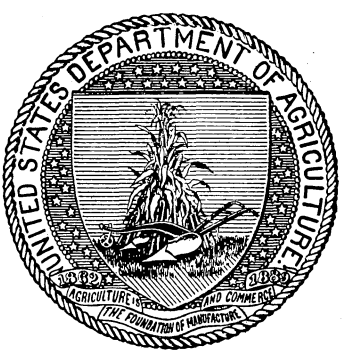

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U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
OFFICE OF THE CHIEF,
Washington, D. C., March 30, 1907.

SIR: I have the honor to transmit herewith a paper entitled "Cost of Filling Silos," by Mr. Lyman Carrier, Scientific Assistant, prepared under the direction of the Agriculturist in Charge of Farm Management Investigations, and recommend that it be published as a Farmers' Bulletin.

Respectfully,

B. T. GALLOWAY,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

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COST OF FILLING SILOS.[a]

INTRODUCTION.

The data contained in the following pages were gathered in the months of September of 1905 and 1906. The writer visited all of the thirty-one farms mentioned in this paper and took notes on the number and arrangement of men and teams, the machinery used, and the length of time taken, and he also made measurements of the silos, etc. Information in regard to the quantities of twine and fuel used and the number of acres cut was given by each individual farmer.

It was thought advisable to confine this inquiry to localities in which the silo has been in use for several years. The places chosen were in Jefferson and Fond du Lac counties, Wisconsin, and in Branch and Lewanee counties, Michigan.

METHODS EMPLOYED.

The methods employed by the different farmers in filling their silos varied greatly, no two being exactly alike. This was occasioned largely by scarcity of help or teams and by the kind of machinery used. With a few exceptions the different methods may be classified in three groups:

(1) The most common practice was to have one man with three horses on a corn harvester cutting corn in the field; two men to load the wagons in the field; three or four men with teams, depending on the distance from the field to the silo, to haul the corn to the cutter; one man to run the engine when steam was used for power, and, occasionally, when gasoline engines were used, one man to feed the cutter and one man in the silo to spread and tramp the silage. Each teamster pitched off his own load. This makes a crew of eight or nine men, exclusive of the man who tends the engine.

(2) In cases where there is a shortage of teams the following method is generally practiced. One man, with three horses, cuts the

[a] For details in reference to the construction of silos, the feeding of silage to farm stock, etc., see Farmers' Bulletin 32, entitled "Silos and Silage."

corn; two men load the wagons in the field; two men, or boys, with teams, haul the corn to the cutter; one man unloads the wagons; one man feeds and one man works in the silo. As soon as a load arrives at the cutter the teamster changes his team for an empty wagon and goes back to the field after another load. When a wagon is unloaded it is run out of the way by hand. With this method boys who are not strong enough to handle the green corn can be utilized to drive the teams. This method requires a crew of six men and two boys, exclusive of the engine tender.

(3) When enough horses are available and help is scarce, the following arrangement of men and teams is a good one. One man, with three horses, runs the harvester in the field; four men with teams haul the corn to the silo; one man feeds and one spreads the corn in the silo. Low trucks or wagons with racks suspended below the axles should be used, so that the teamsters can put on their own loads. (See fig. 1.) This requires a crew of seven men, besides the engineer.

Table 1 gives a comparison of these three methods.

TABLE 1.—*Number and arrangement of men employed in filling silos by various methods.*

Kind of work.	Method 1.	Method 2.	Method 3.
Operating binder	1	1	1
Loading wagons	2	2	0
Driving teams	3 or 4	2 (boys)	4
Unloading wagons	Teamsters.	1	Teamsters.
Feeding cutter	1	1	1
In silo	1	1	1
Total number of men	8 or 9	8	7
Number of teams hauling	3 or 4	2	4

The difference between methods is in the arrangements for loading, hauling, and unloading. When there is a sufficient number of teams, the teamsters do their own loading and unloading. When teams are scarce, two loaders and one unloader are needed; but boys may drive the teams to and from the field.

In figuring out the cost of filling, the silos were measured and the amounts of silage determined from King's tables. It must be borne in mind that these weights are for cured silage. The actual weights of green corn put in the silos would be from 15 to 25 per cent greater than those mentioned.

The cost of labor varied considerably. In order to compare the different methods, a uniform rate of 15 cents an hour was made for men and the same for a team of two horses. Engine hire was rated at $4.50 a day, which includes the engineer. This may be too high in the case of gasoline engines, as they did not require attention all of the time; yet they caused more delays from getting out of order than

did the steam engines, which probably offset the difference in attention demanded.

Twine was rated at 11½ cents a pound, coal at $5 a ton, and gasoline at 13 cents a gallon. No charge was made for wear and tear on machinery or for boarding the help. Nearly every one of these men owned his silage cutter. The others depended on hiring cutters. The charge for an engine, engineer, silage cutter, and one man to feed is usually $10 a day.

Ten hours were considered a day's work. No deductions were made for delays unless the helpers were set at some other work. The average quantity of silage cut daily by each man was computed by dividing the number of tons of silage cut by the total hours worked and multiplying the result by ten.

TABLE 2.—*Itemized statement of the equipment, etc., used in filling silos on 31 farms, with cost per ton of silage.* (*Arranged in order of total cost.*)

No. of farm.	Length of haul.	Silage cut.			Area cut.	Yield per acre.	Number of days cutting.	Kind of engine.	Size of engine.	Kind of fuel.	Length of cylinder.	Length of cut.	Kind of elevator.	Cost per ton of silage.					
		Total quantity.	Daily quantity.	Daily quantity per man.										Labor.	Teams.	Twine.	Fuel.	Engine hire.	Total.
	Rods.	*Tons.*	*Tons.*	*Tons.*	*Acres.*	*Tons.*			*H. P.*		*Inches.*	*Inches.*							
1	60	285	57	6.95	22	12.94	5	Gasol...	15	Gasol...	15	¾	Blower.....	$0.21	$0.12	$0.03	$0.02	$0.08	$0.46
2	10	43	43	6.14	4	10.75	1	Gasol...	10	Gasol...	13	¾	Blower.....	.23	.07	.03	.03	.12	.48
3	30	103	68.7	6.88	14	7.4	1.5	Steam..	16	Coal....	17	¾	Blower.....	.22	.12	.05	.03	.07	.49
4	50	90	60	7.15	14	6.4	1.5	Steam..	12	Coal....	15	¾	Blower.....	.21	.13	.05	.04	.08	.51
5	40	242	44	6.83	20	12.1	5.5	Steam..	12	Coal....	15	¾	Blower.....	.22	.13	.03	.03	.10	.51
6	80	169	48.4	6.05	15	11.3	3.5	Steam..	10	Wood...	18	¾	Carrier.....	.25	.12	.03	.02	.09	.51
7	30	140	61	7.42	16	8.75	2.3	Steam..	10	Coal....	18	¾	Carrier.....	.20	.17	.03	.05	.08	.53
8	30	180	48	6.48	20	9	3.75	Steam..	12	Coal....	13	1	Carrier.....	.23	.16	.05	.02	.09	.55
9	30	103	37.5	6.15	12	8.6	2.75	Steam..	12	Coal....	16	½	Carrier.....	.25	.14	.03	.02	.12	.56
10	20	130	52	5.2	8	16.3	2.5	Gasol...	10	Gasol...	13	¾	Blower.....	.29	.13	.02	.02	.10	.56
11	80	630	47.8	5.68	57	12.5	13.2	Gasol...	12	Gasol...	20	¾	Carrier.....	.26	.15	.03	.03	.09	.56
12	40	205	34.2	6.51	21	9.8	6	Steam..	10	Coal....	18	¾	Carrier.....	.24	.14	.04	.04	.13	.59
13	240	123	61.5	5.6	20	6.1	2	Steam..	12	Coal....	15	¾	Blower.....	.27	.18	.05	.03	.07	.60
14	60	135	54	5.4	16	8.5	2.5	Steam..	10	Coal....	20	¾	Carrier.....	.28	.16	.05	.03	.08	.60
15	30	325	46.5	5.33	19	17.1	7	Steam..	12	Coal....	15	¾	Blower.....	.28	.14	.04	.06	.10	.62
16	120	810	57.8	4.45	85	9.6	14	Steam..	12	Coal....	20	¾	Carrier.....	.34	.16	.00	.05	.08	.63
17	80	123	49.3	5.37	18	6.4	2.5	Steam..	10	Coal....	20	¾	Carrier.....	.28	.17	.07	.03	.09	.64
18	30	450	42.8	4.13	33	13.6	10.5	Steam..	12	Coal....	22	¾	Carrier.....	.36	.13	.04	.03	.11	.67
19	80	130	47.3	4.58	20	6.5	2.75	Steam..	20	Coal....	15	¾	Blower.....	.33	.14	.04	.07	.09	.67
20	50	177	28.5	5.9	20	8.9	6	Gasol...	15	Gasol...	15	¾	Blower.....	.25	.20	.05	.03	.15	.68
21	100	90	32.7	4.5	10	9	2.75	Gasol...	10	Gasol...	10	¾	Carrier.....	.33	.16	.04	.03	.14	.70
22	120	640	42.7	4.25	85	7.5	15	Steam..	12	Coal....	15	¾	Blower.....	.35	.18	.03	.03	.11	.70
23	30	148	33	4.49	18	8.2	4.5	Gasol...	8	Gasol...	18	¾	Carrier.....	.33	.16	.05	.03	.14	.71
24	80	130	25	4.65	15	8.7	5	Steam..	10	Coal....	15	¾	Carrier.....	.28	.20	.04	.03	.17	.72
25	320	68	34	3.43	7	9.7	2	Gasol...	10	Gasol...	15	¾	Blower.....	.44	.16	0	.02	.13	.75
26	45	114	41.5	4.08	13.5	8.5	2.75	Steam..	12	Coal....	20	¾	Carrier.....	.36	.20	.07	.03	.11	.77
27	80	350	35	4.38	30	11.6	10	Gasol...	15	Gasol...	16	1	Carrier.....	.34	.22	.05	.04	.13	.78
28	160	70	46.7	3.59	9	7.8	1.5	Steam..	10	Wood...	13	¾	Blower.....	.42	.18	.04	.06	.10	.80
29	40	135	30	3.91	20	6.8	4.5	Steam..	10	Coal....	18	¾	Carrier.....	.38	.18	.06	.05	.15	.82
30	60	195	30	3.75	25	7.8	6.5	Gasol...	11	Gasol...	16	¾	Carrier.....	.40	.21	.05	.03	.15	.84
31	60	60	40	3.33	11	5.6	1.5	Steam..	10	Coal....	17	¾	Carrier.....	.45	.20	.04	.05	.12	.86

The average yield of silage per acre was 9.01 tons. The average cost per ton of silage was 64 cents. The average amount of silage cut daily per man was 4.9 tons. The average cost per acre for putting the corn in the silo was $5.98.

ARRANGEMENT OF LABOR.

The following table shows the distribution of the men employed in cutting, loading, hauling, feeding, etc.:

TABLE 3.—*Arrangement of labor in filling silos on 31 farms.*

No. of farm.	Cutting corn.		Loaders.	Hauling—men and teams.	Pitching off.	Feeders.	In silo.	Engineers.	Total number of men.	Remarks.
	Men.	Horses.								
1	1	3	2	3	Teamsters.	1	0	0	7	
2	1	2	1	1	2	1	1	1	8	
3	1	3	2	4	1	1	1	1	11	Teamsters helped unload.
4	1	3	2	4	Teamsters.	1	1	1	10	
5	1	3	2	3	Teamsters.	1	1	1	9	
6	1	3	2	3	Teamsters.	1	1	1	9	
7	1	4	0	4	Teamsters.	1	1	1	8	Changed teams on binder every hour.
8	1	3	1	3	Teamsters.	1	1	1	8	
9	1	3	2	3	Teamsters.	1	1	1	9	
10	1	3	2	3	Teamsters.	[a] 2	2	1	11	
11	1	3	3	3	Teamsters.	1	0	0	8	Had man in silo last two days.
12	1	3	2	2	1	1	1	0	8	One boy drove team.
13	1	3	3	6	Teamsters.	1	1	1	13	
14	1	3	2	4	Teamsters.	1	1	1	10	
15	1	3	3	3	Teamsters.	1	1	1	10	
16	1	2	3	5	Teamsters.	[a] 2	2	1	14	Did not use any twine.
17	1	3	3	4	Teamsters.	0	2	1	11	Engineer helped feed the cutter.
18	1	3	2	2	1	1	1	1	9	Two men in silo last two days.
19	1	3	3	3	Teamsters.	[a] 2	2	1	12	
20	1	3	0	3	1	0	1	0	6	
21	1	3	3	2	Teamsters.	[a] 2	0	0	8	
22	1	3	2	4	Teamsters.	1	2	1	11	
23	1	3	2	2	1	1	1	1	9	
24	1	3	2	2	1	1	1	0	8	One boy drove team.
25	3	3	2	4	Teamsters.	1	2	1	13	Binder failed; cut mostly by hand.
26	1	3	2	4	Teamsters.	1	2	1	11	One man in silo first day.
27	1	3	1	3	Teamsters.	1	1	1	8	
28	1	3	4	4	Teamsters.	[a] 2	2	1	14	
29	1	3	2	2	1	1	1	1	9	
30	2	4	1	4	Teamsters.	1	1	1	10	Three teams hauling first 2½ days.
31	1	3	3	4	Teamsters.	[a] 2	2	1	13	

[a] Cutter did not have self-feeding attachment.

The question at once arises, Why can some farmers fill their silos at a cost of 46 cents a ton while it costs others 86 cents? Quite often the higher cost is due to unavoidable causes, such as long hauls, lodged and tangled corn, and accidents to machinery. In many cases, however, a poor arrangement of the help is responsible for the extra expense. The best method is that in which the working force is the most evenly balanced; that is, where all are working continually. It is not necessary that men and teams should be rushed to their fullest extent in order to get the work done cheaply. Some of the most expensive work was conducted with the greatest furore and hurry. The scheme where all are working and no one is hindered by the others

is the most economical. Too many men in the field for the number at the cutter, or vice versa, and too large a crew for the size of the silage cutter are common sources of loss. Two or three men and teams with loaded wagons waiting their turns to unload, a similar condition in the field where they are waiting to be loaded, or a delay owing to a lack of teams represents a decided loss of valuable time. The factor that controls the size of the crew is the capacity of the silage cutter.

At farm No. 28 too many men were employed (see Table 3). If there had been only two men instead of four pitching on in the field, three men instead of four with teams hauling, and one man instead of two in the silo, just as much silage could have been cut in the same length of time. The cutter was of medium size—too small for the number of men supposed to be at work. Deducting the wages of the four men and one team that were not needed would lower the cost of filling at this place from 80 cents to 64 cents a ton.

A small cutter may be used almost as economically as a large one, but most farmers wish to get the silo filling done as quickly as possible and so prefer the larger machines. There was only 2 cents per ton difference between the cost on farms 7 and 8, yet at No. 7 a new machine with an 18-inch cylinder was used, while at No. 8 a 13-inch cylinder machine that had been in service eighteen years was still in use.

SIZE OF LOADS.

There seems to be an inverse ratio between the size of loads hauled and the cost per ton for filling. It is unfortunate that a record of the total number of loads was not kept for each farm. The importance of this feature was not fully appreciated at the beginning of the study. The table below gives the average size of load on ten farms where such a record was kept. As before stated, the weights given are for cured silage and are not the weights of the green corn as it comes from the field.

TABLE 4.—*Relation of size of loads to total cost of silage.*

No. of farm.	Size of loads.	Cost per ton of silage.	No. of farm.	Size of loads.	Cost per ton of silage.
	Tons.			*Tons.*	
1	1.37	$0.46	16	0.72	$0.63
2	1.54	.48	19	.76	.67
4	1.00	.51	26	.75	.77
10	1.16	.56	28	.90	.80
15	.94	.62	31	.77	.86

The extra large loads hauled at farm No. 2 kept the cost remarkably low. There was only one team with two wagons hauling. Had smaller loads been drawn, the help of the eight men employed

could not have been utilized to good advantage. The men, teams, and machinery at farm No. 14, where the cost was 60 cents, were almost identically the same as those at No. 26, where the cost was 77 cents. No record was kept of the total number of loads hauled at these two farms, but the loads at farm No. 26 were much smaller than those at No. 14, owing to a steep hill that had to be climbed to reach the cutter. It is difficult to explain in any other way the difference in cost of 17 cents a ton at these two farms.

CROPS USED.

At farm No. 22 a 20-acre field of alfalfa was ready to cut at silo-filling time. The owner tried the experiment of putting the green alfalfa in the silo, mixing it with corn. The alfalfa was cut with a mowing machine and raked into windrows with a 2-horse hayrake. One man with a team was set to hauling the alfalfa while three were hauling corn. It is not a difficult matter for one man to put on a load of this green stuff alone. The man who did this work would bring in five big loads a day, estimated at 2 tons each. The three men and teams hauling corn, with two loaders in the field, would draw from 35 to 40 loads in that time. The silo was an extra large one, over 38 feet in diameter, and so the two crops were quite evenly mixed.

Corn alone was used at all of the other farms. There is considerable difference of opinion as to the relative value of different varieties of corn for silage. Some farmers grow very large southern kinds that do not mature grain in latitudes as far north as Michigan and Wisconsin. Others prefer the ordinary dent sorts which produce a large percentage of grain. The total amount of digestible matter per acre is about the same, whether it is a large ensilage corn or the ordinary field variety, the difference in bulk being mostly water. Some farmers combine the two by planting 1 part of some large southern variety and 2 parts of common field corn. This is said to make a very satisfactory silage.

CONDITION OF THE CROPS WHEN CUT.

A few years ago it was thought necessary to ensilage corn in an immature state in order to have it keep. This made a sour silage with a strong pungent odor. The consensus of opinion now favors letting the corn go until the grain is fully matured. In ordinary seasons there is a period, lasting but a few days, in which the corn ears are ripe and the leaves and stalks are green. This is the ideal time for putting it in the silo. If the corn is allowed to mature beyond this stage, water should be added to the cut material at filling time

to prevent "fire fanging" of the silage. The results of many chemical analyses show that the food materials in the corn plant increase very rapidly as the plant approaches maturity, and do not reach their maximum until it is fully ripe. Most feeders prefer the silage made from mature corn because it contains less acid and possesses a milder odor than it does when cut in a greener condition.

EQUIPMENT.

HARVESTERS.

With the price of labor high and help difficult to obtain it becomes necessary to take advantage of all the labor-saving machinery possible. The corn binder has come to be almost indispensable at silo-filling time. Most of the farmers whose work is described herein owned their own harvesters. The others were able to hire them.

The cost of cutting corn with a machine is about the same as when it is cut by hand and laid in small bunches on the ground. But there is a considerable saving of time in handling bundles rather than loose stalks. It takes fully twice as long to unload the same quantity of corn when loose as when in bundles. At farm No. 16 (Table 2) the corn was cut with a harvester, but no twine was used. It is evident that the increased cost of labor more than offset the saving of three or four cents per ton of silage for twine. Several inventors are trying to construct a corn harvester with an elevator attachment to load the corn as soon as cut on a wagon driven alongside. Some of these machines give promise of success.

WAGONS.

Until a loader has been perfected the style of wagon used in hauling needs careful consideration. The rack should be as low as possible. A low, solid-wheel truck gives good satisfaction on smooth, level farms, with short hauls. The draft is too heavy for other conditions.

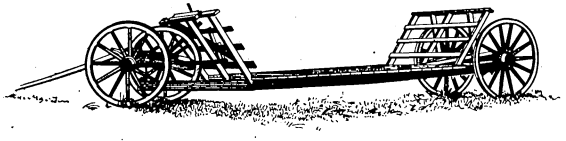

FIG. 1.—Rack for hauling green corn.

The rack that is quite commonly used in Wisconsin, figure 1, consists of two 4 by 6 inch bed pieces, 18 or 20 feet in length, bolted together at one end to form a V. On top of these timbers is built a rack 6 feet in width. The bottom of this rack is about 8 feet long. The end boards are 4 feet high, built flaring so they do not quite touch the wheels. The apex of the V is suspended below the front axle of an

ordinary farm wagon by means of a long kingbolt. The other ends are attached below the hind axle by U-shaped clevises. This rack can be easily made. The materials needed in its construction are 80 board feet of 4 by 6 inch plank, 96 feet of boards 1 by 12 inches, 22 feet of lumber 2 by 4 inches, 1 long kingbolt, 2 stirrup rods, and bolts and nails.

Hauling green corn is heavy, tiresome work, and too much attention can not be paid to details of method in order to avoid unnecessary lifting. Before the advent of the corn harvester, when the corn was cut by hand and hauled unbound, it was a common practice to have the cutter set on a platform about 2½ feet above the ground. A man could pick up an armful of corn on the wagon and stepping on the platform place it on the feeding table. With the corn bound in bundles this arrangement causes much extra labor; nevertheless many farmers still keep the cutter upon the platform and lift the corn up to it when they could much more easily drop it on the table if the cutter were down on the ground.

SILAGE CUTTERS.

There are several first-class silage cutters on the market—machines that will cut the corn as fast as two men can pitch it on the table. The self-feeding table that is found on most of the modern cutters saves the labor of at least one man. This table should be long enough to hold two bundles of corn lapped at the bands.

ELEVATORS.

There are two types of elevators in general use. One is the old-style slat, or rattle carrier, and the other is the blower, in which the cut corn is forced up through a tube by means of a current of air. (See figs. 2 and 3.) The chief objection to the blower machine is that it takes so much power to run it. While the blower requires more power to operate than does the slat carrier, very few blowers require more than a 12-horsepower engine. With but one exception the power used on any one of these 31 farms would have been sufficient to run a medium-sized blower machine, and in most cases would have handled the largest machines without any trouble. It is interesting to note that blower machines were used by the five men having the lowest cost per ton of silage. Where the carrier elevators were used it cost on an average 65 cents per ton to fill the silo, while it cost those who used the blower elevators 61 cents. A carrier unless covered on top and fitted with a return trough underneath is very untidy, especially during windy weather. At one place there was litter to the depth

of half a foot about the silo that had blown out of the carrier. This trouble is avoided by the use of the blowers.

FIG. 2.—Filling a silo by means of a slat elevator having a closed top and return trough underneath.

The blower pipe should stand as nearly perpendicular as possible. In one case that was called to the writer's attention a blower at first proved unsatisfactory. The trouble lay in having the cutter set too far from the silo, with the pipe leaning at an angle of 30 degrees from the perpendicular. The pipe clogged frequently, and a 12-horsepower engine was insufficient to handle the cutter when it was crowded to anything like its full capacity. After two days of annoyance and discouragement the owner changed the position of the machine, putting it close to the silo. The difference could be noticed at once. There was no further trouble from lack of power, and it was impossible to clog the pipe by overfeeding.

FIG. 3.—Blower elevator in correct position for filling silo.

SILAGE DISTRIBUTERS.

In a silo more than 36 feet in depth it is not necessary to have a man to tramp the cut corn. If the surface is leveled two or three times a day while filling, the silage will pack sufficiently to keep. But there is one objection to doing this. If the cut corn is allowed to pile up in the form of a cone, the heavier parts will roll to the outside of the pile and the grain and leaves will not be evenly mixed.

Several devices have been invented for distributing the cut material in the silo, but few of them are successful. One of the most satisfactory distributers where a blower is used consists of two boards, 8 or 10 inches wide and about half as long as the diameter of the silo, nailed together at right angles to form a trough. A 12-inch board is nailed over one end of this trough, the other end being left open. For use, the trough is suspended from the roof with the open side downward and the closed end toward the center of the silo. The open end rests above the top of the blower pipe. As the cut material leaves the pipe it follows along this trough until it strikes the closed end; then it is scattered about the silo. If a little care is exercised in adjusting this device, it will give very good results.

PARTNERSHIP ARRANGEMENTS AMONG FARMERS.

The high cost of machinery for cutting silage and the difficulty in securing help prevent many farmers from building silos. It is highly important to be able to get an outfit when it is needed. An early frost or a spell of hot, dry weather may so affect the crop that it is necessary to fill the silo several days before the usual time. For this reason a man should own his cutter and engine, especially if enough silage is cut each year to warrant this outlay of capital. It is usually easier to hire an engine than it is a cutter. For this reason many buy the latter and depend on being able to rent the former when it is needed. The next best arrangement to owning an outfit individually is for two or three farmers in the same neighborhood to buy the necessary machinery in partnership.

The owners of farms Nos. 14, 17, and 26 bought a silage cutter together. At filling time each man furnishes two laborers and one team while the others are filling. By varying the seeding time in the spring they have been able to control the time of harvesting so that all three get their silos filled with corn in good condition.

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